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Newsletter

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Spruce Budworms
Program

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Past And Present Outbreaks Of Spruce Budworm

It is an accepted fact that spruce budworm outbreaks are a natural phenomenon associated with the biotic of the boreal forest in eastern North America. Reconstruction of the history of past outbreaks for various regions for periods of two to three hundred years has been possible through ring-growth studies of old white spruce trees.

Data on past outbreaks indicate that epidemics of this insect do not recur at regular intervals (Table 1). From data from central Quebec covering a period of three centuries, the approximate intervals between seven outbreaks, starting with the earliest known one that began in 1704, are 44, 60, 30, 79, 39, and 30 years. The six outbreaks that occurred in southern Quebec, northern New Brunswick and Maine starting with the one in 1760, were at intervals of 42, 75, 34, 39, and 27 years. These irregular intervals indicate that the occurrence of any future outbreaks cannot be accurately predicted on the periodicity of past ones.

In the past 200 years, outbreaks recurred more frequently in the Atlantic sector than in Ontario. During this time, spruce-fir stands within some regions in the Atlantic sector were subjected to four outbreaks, while pulpwood stands within regions in Ontario with the exception of the Lac Seul region, suffered only two attacks. In the Lake Nipigon region, 138 years elapsed between these two outbreaks, and in the Algoma region, the interval was 98 years. This is considerably longer than the average interval for regions in the Atlantic sector.

Two main conditions are required before endemic populations of this insect reach outbreak proportions: there must be extensive stands of mature balsam fir, and there must be a period of three to four years of early summer drought. The climate of Ontario is drier than the climate of the Atlantic sector. Conversely, balsam fir is more common in the east than further west. Therefore, optimum forest conditions for spruce budworm outbreaks occur in the Atlantic sector, while optimum weather conditions occur in Ontario. It appears that forest conditions are a more limiting factor in Ontario than climate in the Atlantic sector since outbreaks occur less frequently in Ontario than in the Atlantic sector. The situation that prevails in Ontario probably applies to Minnesota where climatic and forest conditions are quite similar to those in northwestern Ontario.

During the twentieth century, outbreaks have recurred at intervals approaching 30 years in some regions, but intervals were generally greater during the eighteenth and nineteenth centuries (Table 1). Also, the degree and duration of radial-growth suppression in host trees, caused by outbreaks, would indicate that outbreaks in the twentieth century were more severe and of longer duration than earlier ones; furthermore, they appear to be more widespread. This could be the result of man's interference with the forest.

Exploitation of pulpwood stands began at the turn of the century. Clearcutting of these stands favors fir at the expense of spruce, thus increasing the vulnerability of fir to budworm attack. Also, the more effective methods of combating forest fires in recent years are resulting in a decrease of burnt-over areas. These, in turn, are causing a decrease in non-budworm host stands that form the forest cover after burns; consequently, spruce-fir stands are becoming more continuous, and more prone to budworm attack.

The outbreak currently in progress in eastern North America, in addition to covering most regions affected during the preceding outbreak in eastern Ontario,

Table 1
Spruce budworm outbreak periods* and intensity of damage for various regions in eastern North America. Number of years between the beginning of outbreaks is shown in brackets.

Region	Area ha	INITIAL YEAR OF OUTBREAK 1704	1748	1760	1802	1832	1863	1877	1911	1932	1943-47	1955	1967-72
Minnesota	1,550,000	—**	—	—	—	—	—	—	S	Nil	Nil	S(44)	Nil
Ontario													
Lac Seul	7,250,000	—	—	—	PS	Nil	S(61)	Nil	Nil	Nil	S(74)	Nil	Nil
Lake Nipigon	2,850,000	PS	Nil	Nil	PS(98)	Nil	Nil	Nil	Nil	Nil	S(138)	Nil	Nil
Algoma	4,660,000	—	—	—	Nil	S	Nil	Nil	Nil	S(100)	Nil	Nil	S(35)
Québec													
Ottawa River	3,885,000	—	—	—	—	PS	Nil	Nil	S(79)	Nil	S(30)	Nil	S(27)
Laurentian Park	2,850,000	PS	PS(44)	Nil	L(60)	L(30)	Nil	Nil	S(79)	Nil	S(33)	Nil	S(26)
Southeastern Quebec	3,885,000	—	—	S	S(42)	Nil	Nil	S(75)	S(34)	Nil	S(33)	Nil	S(26)
Gaspé	2,590,000	—	—	—	—	Nil	Nil	Nil	L	Nil	S(37)	Nil	S(24)
New Brunswick and Maine	7,770,000	—	—	S	S(42)	Nil	Nil	S(75)	S(34)	Nil	S(34)	Nil	S(24)***
Nova Scotia													
Cape Breton	770,000	—	—	—	—	—	—	—	S	Nil	S(36)	Nil	S(34)
Newfoundland	2,700,000	—	—	—	—	—	—	—	Nil	Nil	L	Nil	S(29)

L = Light, S = Severe, PS = Probably severe.
* Approximate year of initial defoliation
** Dashes indicate no data available
*** The outbreak that began in the late 1940's receded in 1959-60 and resurged in 1971.

Quebec, the Maritime provinces and Maine, is seriously affecting certain regions only lightly attacked 30 years ago such as Newfoundland, and the Lower St. Lawrence and Eastern Townships in Quebec. Even more significant is that certain regions with no record of previous outbreaks are currently under attack; these include parts of the North Shore of the St. Lawrence, Anticosti Island, and Labrador.

Man's greatest interference with the existing relationship between the budworm and the forest may result from the aerial application of insecticides over vast regions. It is now known that continued aerial application of insecticides over vast regions can prolong the duration of outbreaks, or shorten the interval between them. This situation is understandable when it is considered that extensive stands of mature fir, that otherwise would succumb to budworm attack, are kept alive as a result of treatment.

Should the trend initiated in this century continue, future budworm outbreaks in eastern North America could become more frequent, more widespread and more severe. Measures, such as forest management, practiced over extensive areas could possibly reverse this trend.

J.R. Blais - Laurentian Forest Research Center

Omission - Newsletter No 4

It has been decided that the name of the author of each feature article and his affiliation be published. Inadvertently, C.A. Miller, Maritimes Forest Research Centre, author of "The Eastern Spruce Budworm" was omitted. Sorry about that Charlie!

Joint Policy and Program Council Meeting

The second meeting of the CANUSA Joint Policy and Program Council — the "Board of Directors" — was convened on May 1, 1979, in Hull, Quebec at the Canadian Forestry Service headquarters. Mr. J. Blair Seaborn, Deputy Minister, Canada Department of Environment opened the meeting with a statement of his expectations of achievements from the CANUSA Program toward economically and environmentally acceptable solutions to spruce budworm problems in both countries. The agenda for the Council was devoted largely to reporting on action items from the previous JPPC meeting: the CFS Task Force evaluation of eastern spruce budworm research; plans for joint evaluation of B.t. programs; USDA-FS Task Force on a problem analysis for application technology; CFS development of spruce budworm sex attractants for surveys and control. The principal policy issue identified the need for international (joint or common) working groups as a means of integrating U.S. and Canadian programs. Further discussion on this issue was scheduled for the next Council meeting — tentatively scheduled for late August, 1979.

1979 Awards For RD&A Work

The following individuals and institutions or agencies have been approved for funding from CANUSA.

All CANUSA awards are made through a competitive process in which proposals are evaluated by a technical review panel. Funds are provided through the Forest Service (FS) or the Science and Education Administration-Cooperative Research (SEA-CR).

Program management is currently negotiating with other scientists and notice of new awards will be made subsequently.

1979 Awards For RD & A Work — Western U.S.

1. Distribution of western spruce budworm egg masses on white fir.
   Schmid, J.M.
2. Associates of western spruce budworm larvae.
   Stevens, Robert E.
3. Pheromone chemistry and taxonomic relationships of selected western spruce budworms.
   Daterman, G.E.; Powell, J.A.; Stevens, R.E.
4. Population dynamics of the western spruce budworm.
   Beckwith, Roy C.; Mitchell, Russell G.; Campbell, Robert W.; Torgersen, Torolf R.
5. Dispersal of Stage I and II western spruce budworm larvae and adults.
   Fellin, David G.
6. Impact of defoliation by spruce budworm on growth and development of young timber stands.
   Stage, A.R.; Foiles, M.W.
7. The effects of spruce budworm on regeneration success.
   Stage, A.R.; Boyd, R.J.
8. Extension of stand prognosis model.
   Stage, A.R.; Monserud, R.A.; Wykoff, W.R.
9. Assess effects of western spruce budworm feeding and defoliation on cone and seed production.
   Shearer, Raymond C.; Tiernan, Charles F.J.
10. Evaluation of long-term fire hazard modification.
    Martin, Robert E.
11. The influence of silvicultural practices on susceptibility and vulnerability of northern Rocky mountain forests.
    Carlson, Clinton, E.; Schmidt, Wyman; Fellin, David G.; Tiernan, Charles F.G.
12. Field tests of an additional insecticide.
    Markin, George P.
13. Field evaluation of *Bacillus thuringiensis* and cranulosis virus.
    Stelzer, M.; Neisess, John
14. Field evaluation of a simulated aerial application spray system.
    Richmond, Charles E.
15. Joint action of pyrethroids with an insect growth regulator.
    Robertson, J.L.
16. Relative insecticidal activity of varieties and isolates of *Bacillus thuringiensis*.
    Thompson, C.G.
17. Screening, characterization, and production of Baculoviruses.
    Martignoni, Mauro E.
18. Enhancing the activity of *Bacillus thuringiensis*.
    Maksymiuk, Bohdan
19. Aerial application of Hercon® formulated pheromone for mating disruption.
    Daterman, G.E.
20. A comparison of evaporation potentials of aqueous and non-aqueous *Bacillus thuringiensis* spray formulations.
    Neisess, John
21. Pheromone-baited trap catch as a predictor of defoliation.
    Sartwell, Charles
22. Evaluation of Orthene® Medicap trunk implants for protecting grand fir and Engelmann spruce.
    Reardon, Richard; Haskett, Michael
23. A multiple regression model for prediction of spruce budworm defoliation.
    Bullard, Allen T.; Young, Robert M.

1979 Awards For RD&A Work — Eastern U.S.

1. Environmental Monitoring of the 1979 Field Test of Matacil.
   Harold L. Brown, Eco-Analysts, Inc., Bath, ME.
2. Pheromone Chemistry and Development of Pheromone Sampling Systems.
   Ring Carde, Michigan State University, East Lansing, MI.
   Wendell Roelofs, N.Y. State Agr. Exp. Sta., Cornell University, Geneva, NY.
3. *Bacillus thuringiensis:* Field Tests of Alternate Formulations.
   John B. Dimond, University of Maine, Orono, ME.
4. Insect Growth Regulators for Management of the Spruce Budworm.
   Jeffrey Grannett et al, University of Maine, Orono, ME.
5. Microclimatic and Phenological Differences in Balsam Fir and White Spruce in Relation to the Development of the Spruce Budworm.
   Yvan Hardy, Laval University, Quebec, Canada.
6. Delineation of Selected Variables Which Affect the Loss of *Bacillus thuringiensis* Crystals from Aerial Sprays.
   F.D. Harris, University of Missouri, Columbia, MO.
   D.B. Smith, USDA-SEA-AR, University of Missouri, Columbia, MO.
7. Efficient Aerial Sprays from New Analytical Biophysical Systems for Mass and Droplet Transport.
   Chester Himel, University of Georgia, Athens, GA.
   Angus J. Howitt, Michigan State University, East Lansing, MI.
8. The Significance of Non-host and Alternative Host Tree Species on Populations of Larval Spruce Budworm.
   William P. Kemp, Environmental Associates, Inc., Orono, ME.
9. A Sunshine Ultraviolet Simulator for Microbial Insecticide Testing.
   Conrad J. Mason, Aeromatrix, Inc., Ann Arbor, MI.
10. Wind Tunnel Evaluation of Aerodynamic Drag Coefficients of Spruce Foliage Elements.
    Donald F. Potts et al, State Univ. of N.Y., CES&F, Syracuse, NY.
11. Analysis of the Integrated Management of Spruce Budworm.
    Christine A. Shoemaker, Cornell University, Ithaca, NY.
    Jery R. Stedinger, Cornell University, Ithaca, NY.
12. Use of Light Trap Data to Assess Changes in Endemic Spruce Budworm Populations.
    Gary A. Simmons, Michigan State University, East Lansing, MI.
13. Improvement of Spruce Budworm Population Sampling for Low and Moderate Population Levels.
    Gary A. Simmons, Michigan State University, East Lansing, MI.
    Gary W. Fowler, University of Michigan, Ann Arbor, MI.
14. Economic Potential of Marketing and Utilizing Spruce-fir Timber from Budworm-Threatened or Damaged Forests.
    Steven A. Sinclair et al, University of Minnesota, St. Paul, MN.
15. Entomophthora fungi as Mycoinsecticides for Spruce Budworm Control.
    Richard S. Soper, Boyce Thompson Inst., Ithaca, NY.
16. Production of Spruce Budworm Baculovirus.
    Gordon R. Stairs, Ohio State University, Columbus, OH.
17. Photometric Derivation of Analytical Parameters for Large Area Forest Management.
    John E. Walker, Calspan Corp., Buffalo, NY.
18. Development of a Rapid and Sensitive Technique to Determine Toxicity of Pesticides, Solvents and Emulsifiers.
    Pearl Weinberger, University of Ottawa, Canada.
19. Evaluation of the Environmental Impact of Matacil using Aquatic Microcosms.
    Pearl Weinberger et al, University of Ottawa, Canada.
20. Matacil and Long-term Microbiological Side Effects in Freshwater Ponds.
    David J. Wildish, Biological Station, St. Andrews, New Brunswick, Canada.
21. Techniques and Plot Establishment for Forest Damage Assessment.
    John A. Witter, University of Michigan, Ann Arbor, MI.
22. Controlled Drop Size Atomizer for Aerial Applications in Forests.
    Wesley E. Yates, University of California, Davis, CA.
    Norman Akesson, University of California, Davis, CA.

IUFRO Meeting Scheduled

Plans are progressing for a joint meeting at Sandpoint, Idaho August 27 - September 1, 1979 of IUFRO Working Parties S 2.07.05 Integrated Control of Scolytid Bark Beetles and S. 2.07.06 Population Dynamics of Forest Insects. A preliminary agenda has been developed and the overall theme of the meeting will be "Dispersal of Forest Insects: Evaluation, Theory, and Management Implications." For additional information on the meeting or arrangements for lodging, contact the following:

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CANADA

Investigator Response To Inventory

In March, we distributed the first issue of the CANUSA R&D Management Inventory to the 204 investigators listed in it. Each investigator was provided with a copy of Basic Record(s) of studies in which he or she is involved, Activity Index, Investigator Index, and Investigator Address List. Also, each was invited to provide feedback to Program Management on the usefulness of the inventory in general and the individual outputs.

Response from U.S. investigators was disappointingly sparse: only 23 of 111 investigators replied. All indicated that the inventory contained useful information to establish communication with other investigators with similar interests. Six respondents provided corrections for the basic record. Only eight offered suggestions on frequency of distribution: quarterly (1); once a year (3); twice a year (4) (in April or May and October).

Most disappointing was that only 2 respondents requested copies of Basic Records on studies or projects other than their own. Does this indicate that most U.S. investigators (1) have full knowledge of related activities in all CANUSA Program Components; or (2) are using other Activity Index and the Investigator Address List to establish communications; or (3) have little interest in activities in other Program components?

On the other hand, Canadian response to the inventory was heavy. Sixty-seven Canadian investigators of a possible 93 (72%) replied: six provided corrections to the basic record; all indicated that the inventory was useful; 12 made suggestions on frequency of publication (7 opted for annual listing, 5 for twice yearly) and 35 requested copies of basic records other than their own. Perhaps the Canadian investigators have missed the annual "Red Book" publication and are now substituting the Inventory for it.

CFS Task Force Reports

The long-awaited CFS Task Force Report on Eastern Canadian Spruce Budworm Research arrived in the hands of management in mid-May. Recommendations were that the CFS structure its research around 10 major areas of concern:

1) To devise rules combining spruce budworm abundance and its impact on host trees, compatible with provincial inventory/management systems, which will allow the forest manager to predict annually within his operational unit the amount and location of tree mortality up to 5 years ahead.

2) To determine how, and within what time periods, the use of budworm-killed trees affects the quality, quantity and value of the product from the mill.

3) To define fire behaviour in budworm-damaged stands, so that the provincial fire managers can allocate their resources accordingly.

4) Using provincial forest data, to provide methods by which forest managers can forecast wood production, as it is influenced by the spruce budworm, for up to 10 years ahead.

5) To define stand characteristics (e.g. stand composition, age class distribution, tree spacing, site and topography) relevant to forest management actions (harvesting, natural and artificial regeneration) that will make budworm outbreaks less likely to occur (less susceptible) or if they do occur, they will minimize damage (less vulnerable).

6) To cooperate with the provincial forest agencies in the building of models for the design and evaluation of alternative strategies for dealing with the spruce budworm/forest problem.

7) To devise methods of increasing the effectiveness and reducing the risks of using currently registered insecticides.

8) To evaluate and develop for operational use new agents for protecting foliage in the year of application.

9) To evaluate and develop for operational use new agents for manipulating budworm numbers which have potential application in strategies other than foliage protection.

10) a) To collate data on the risks associated with the use of new or modified agents, necessary for their registration.

b) In cooperation with other agencies, to provide and continually refine methodologies and protocols for the environmental impact assessment of operational control programs.

c) In cooperation with other agencies, to determine the causes of unexpected environmental impacts of control operations as they are identified by routine environmental monitoring.

CFS management met at the Bristol Place Hotel, Toronto, May 30-31 to discuss the recommendations and to formulate an implementation plan.

Response To Canadian Questionnaire On Newsletter Number 3

A questionnaire was sent to all Canadian recipients of Newsletter No. 3. Of the 231 recipients canvassed, 156 responded (67%). One hundred and forty-nine persons wished to remain on the mailing list, and of the 7 that asked to have their names removed, 4 indicated that they had retired. There were 28 favorable comments and 4 negative (one very negative indeed!). Nineteen new names were suggested as additions to the mailing list. Apparently we are having some impact.

Publications

1. *Key to Small Lepidopterous Larvae in Opening Buds and New Shoots of Douglas-Fir and True Firs* by V.M. Carolin, Jr. and Robert E. Stevens. 1979. Research Note RM-365. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
2. *Spruce Budworms Bibliography* by Daniel T. Jennings, Fred B. Knight, Susanne B. Hacker and M.E. McKnight published by the Canada/United States Spruce Budworms Program and the School of Forest Resources, University of Maine at Orono. While the supply lasts, single copies are available from Program Manager, CANUSA—East, USDA Forest Service, 370 Reed Road, Broomall, Pennsylvania 19008. In the future, we hope to have this publication available through the National Technical Information Service system.

   This bibliography contains 1500 references to literature on coniferophagous budworms. Emphasis is placed on spruce budworm, *Choristoneura fumiferana* (Clemens), and the western spruce budworm *C. occidentalis* Freeman. To a lesser extent, references to literature on spruce-, fir- and pine-feeding *Choristoneura* are also included.

Symposium Proceedings Available

The "Symposium on the Spruce Budworm," held in Alexandria, Virginia in November, 1974, defined the spruce budworm as a problem of international concern. In this sense, the symposium set the stage for the CANUSA Spruce Budworms Program. The purpose of the symposium was to review the spruce budworm situation in North America, and to synthesize past, present, and future research efforts. Contributors represented a diversity of occupations and interests from Federal, State, and Provincial agencies, universities, and private industries in the United States and Canada. Copies of the proceedings of this important meeting are free and available by asking for Miscellaneous Publication No. 1327 from M.E. McKnight, Canada/United States Spruce Budworms Program, USDA Forest Service, P.O. Box 2417, Washington, D.C. 20013.

Where Are You?

If you have moved, changed programs, require corrections to your address, or wish to contribute to the Newsletter, please let us hear from you. Please communicate with your Program Leader:

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